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Money Demand in the United States

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Abstract

This paper considers the demand for various monetary aggregates with a view to assessing their potential roles as intermediate variables for monetary policy. Illustrative estimates using a generalized autoregressive distributed lag model are presented. For M1, the results support an "error correction" model. However, the demand function for M1 may still be subject to shifts due to the continuing process of financial reform and innovation. The demand function for M1A resulting from the particular empirical strategy used in this paper is not well behaved. The estimated equation for M2 is well behaved and robust, though the use of M2 as an intermediate target variable is questionable due to an inability accurately to control it.

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Contents

Summary

In recent years, the U.S. Federal Reserve has been relying less on monetary aggregates and more on a broad range of economic and financial variables in conducting monetary policy. This trend was further emphasized in 1987 when the Federal Reserve decided to cease specifying an annual growth range for M1, the variable that had been viewed historically as the most reliable monetary aggregate in indicating changes in nominal income growth. This paper discusses and evaluates some of the factors underlying these changes.

The performance of velocity models is examined first. Various explanations for the pronounced reversal since 1981 of the previous steady upward drift in M1 velocity are considered, including the recent rapid pace of regulatory reform in financial markets. Also discussed is the possibility of using a different monetary aggregate to resolve the velocity riddle. In particular, the suggested use of M1A, which excludes interest-bearing deposit accounts, is evaluated. Evidence purporting to demonstrate the superior targeting ability of M1A is found to be inconclusive.

In light of the breakdown in simple M1 velocity models, the paper then presents illustrative estimates of more fully articulated money demand equations. The primary focus is on the estimation of the demand for real M1 balances. The results suggest that an "error correction" model may be an appropriate representation of real M1 demand. The forecasting accuracy of the resulting equation is such, however, as to suggest that the demand function for M1 may still be subject to shifts owing to the continuing process of financial reform and innovation. The regression results also confirm that the interest elasticity of demand for M1 has increased. This implies an increased sensitivity of M1 demand to unanticipated shocks, reducing the value of that aggregate as an intermediate target.

With regard to the other monetary aggregates, the estimated equation for real M1A demand resulting from the particular empirical strategy used in this paper is not well behaved--it implies explosive behavior in the sense that if M1A demand is greater than desired in a given period, then demand will increase in the next period. The estimated equation for the demand for real M2 balances, on the other hand, is well behaved. Nevertheless, there are questions about the use of M2 as an intermediate target variable owing to an inability accurately to control it.

Money Demand in the United States

I. Introduction

In 1975 the Federal Reserve began publicly to announce monetary growth targets. It viewed such targets as being proxies for the more fundamental objectives of policy, notably, to foster financial conditions conducive to sustained growth with reasonable price stability. In 1978, the Full Employment and Balanced Growth (Humphrey-Hawkins) Act was enacted which requires the Federal Reserve to set annual target ranges for monetary aggregates, and to report these targets to Congress twice a year.

As the decade of the 1980s progressed, however, the Federal Reserve began to rely less on monetary aggregates and more on a broad range of economic and financial variables as indicators of underlying economic trends. This "electic" approach to monetary policy arose because money was becoming a less accurate proxy for the ultimate policy targets. This shift in emphasis concerning the role of monetary aggregates was reinforced in 1987 when the Federal Reserve decided to cease specifying an annual growth range for M1, the variable which historically had been viewed as the most reliable monetary indicator of changes in nominal income growth. Further, although target ranges for M2 and M3 were established in 1987, the Federal Reserve stated in its midyear report to Congress that under certain circumstances shortfalls from those ranges could well be appropriate. 1/ Such shortfalls occurred. Notably, growth of M2 in 1987 was only 4 percent, well below the lower bound of its 5 1/2 to 8 1/2 percent annual growth range.

Federal Reserve policy in 1988 concerning the role of monetary aggregates further confirms the trend of earlier years. Again, no range for M1 has been specified. Further, in light of the perceived increased uncertainty about the links between money on the one hand and prices and spending on the other, the ranges which were specified for M2 and M3 were widened by one percentage point to 4 percentage points.

The intent of this paper is to discuss and evaluate the extent and nature of the changes in the established empirical relationships between monetary aggregates and other economic variables, focusing on models both of velocity behavior and of money demand. The discussion will bring out that a number of factors can be adduced to explain and hence mitigate the instabilities which are now evident in both velocity and money-demand models. Some instability, however, remains. Further, the

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1/ M1 consists of currency and checkable deposits; M2 consists of M1 plus a variety of small-denomination savings-type instruments used by banks and other financial intermediaries; M3 includes in addition to M2 certain large-denomination instruments, such as large certificates of deposit.

evidence indicates that the interest-elasticity of demand for money has increased in recent years. It will be concluded that on balance the immediate restoration of the targeting roles of monetary aggregates appears unlikely. At a more specific level, this paper will confirm the conclusion of others in the sense that, the broader the monetary aggregate under consideration, the better-behaved the estimated function. This presents the Federal Reserve with a quandary: the more accurately a monetary aggregate tracks a relevant nominal aggregate the more difficult it will be for the Federal Reserve to control that variable.

II. Velocity Models

1. Background

The theoretical framework underlying velocity models is well known and is exhaustively surveyed elsewhere (e.g. Laidler (1985)). Accordingly, only the main features will be highlighted. Specifically, velocity models can be interpreted as being derived from a stable money-demand function, where the demand for money is written as:

$$M = f(Y,\bar{X}) \qquad (1)$$

where M refers to the monetary aggregate under consideration, Y is a nominal scale variable, and $\bar{X}$ is a vector referring to all other factors, such as interest rates, which might influence money demand.

The choices of which specific variables to use to represent these theoretical quantities are interdependent. For example, if the demand for M1, a relatively narrow definition of money, is under consideration, then since an important rationale for holding M1 lies in its ability to satisfy transactions needs, GNP might be the appropriate scale variable. 1/ Alternatively, if a broader definition of money is the focus of analysis and if, as a result, portfolio allocation decisions across differing forms of financial wealth are considered to be important, then wealth might be a more appropriate scale variable. Since it has received the most attention in the empirical literature, and given its traditionally important role as an intermediate target variable for nominal GNP and inflation, the focus of this appendix will initially be on M1. The demand for other monetary aggregates will be analyzed as appropriate.

Given a number of technical conditions, equation (1) can be rewritten as:

1/ Views on this are not unanimous. For example, some argue that consumer expenditures would be a more appropriate scale variable for transactions demand. See, for example, Mankiw and Summers, (1986).

$$M = Y.f(\bar{X})$$

whence:

$$\frac{Y}{M} = \frac{1}{f(\bar{X})} = g(\bar{X}) = V \qquad (2)$$

where V is velocity. The importance of this equation lies in the fact that if V is stable over time then money will track changes in the scale variable. 1/ In particular, M1 would then track nominal GNP, making M1 a useful intermediate-target variable.

2. Recent developments

Chart 1 characterizes the behavior of M1 velocity, measured as the ratio of nominal GNP to M1. For many years, even though it was not constant, velocity tended to move in a relatively predictable fashion--for the period 1946 through 1981, velocity grew at an annual average rate of about 3.6 percent per annum. 2/ However, around 1981, a break occurred and since that time M1 velocity has tended to decline and has been unstable.

A large and growing body of literature has been devoted to explaining this shift in the behavior of velocity. Loosely, the explanations that have been advanced can be classified by whether they assume the shift is due to a misspecification of the velocity model, to underlying structural changes, and/or to cyclical or volatility factors. To elaborate on the distinction between structural and cyclical/volatility factors, refer back to equation (2). In essence, structural changes would imply that the functional form g(.) has altered while cyclical/volatility changes imply unusual variability in the arguments of that function. To the extent that either of these two factors prove to be important, what is needed is a more comprehensive approach to estimating money demand.

An important question that arises in examining the possibility of model misspecification is that of the appropriate choice of monetary aggregate in terms of which the velocity model should be defined. At issue is whether M1 velocity models alone broke down in the early 1980s.

1/ Note that this formulation assumes an income elasticity of money demand of unity. It will be pointed out later that, in the case of demand for M1, there are good theoretical and empirical grounds for assuming that this elasticity is less than unity. This would not qualitatively alter the velocity analysis since the crucial point is that the relationship be stable.

2/ See Stone and Thornton (1987).

In this connection, the Federal Open Market Committee (FOMC) has argued that M1 is more affected than are the broader monetary aggregates by the continuing process of deregulation since M1 contains a disproportionately large volume of interest-earning accounts that serve not only as transactions balances but also as savings vehicles and yet is not sufficiently comprehensive to internalize shifts of funds between liquid assets motivated by rate of return considerations. 1/ The relevant interest-bearing accounts in M1 are the NOW and Super NOW (SNOW) accounts which were introduced nationwide in the 1980s. The FOMC pointed out that since interest rates on these accounts have tended to be relatively sticky, large flows have occurred between these and other savings vehicles in response to small changes in market interest rates. As a result, the behavior of M1 velocity became volatile.

This might suggest that a broader monetary aggregate be substituted for M1 in the velocity model. However, the broader the monetary aggregate under consideration the less will be the control of the Federal Reserve over that aggregate. Alternatively, on the grounds that NOW and SNOW accounts may be held for savings purposes, thereby weakening the transactions based link between M1 and nominal output and prices, use of a definition of money which excludes these accounts might be indicated. 2/

In his time-series analysis of velocity behavior, Rasche considers the empirical implications of using monetary measures which exclude NOW-type accounts (Rasche (1987)). He finds that velocity shifts similar to those in M1 occur in currency velocity measures, adjusted monetary base velocity measures, and to a lesser extent in M1A velocity measures. 3/ Stone and Thornton arrive at a similar conclusion concerning the role of M1A. Against this, Mascaro, in his comment on Rasche's work, argues that, in terms of Rasche's own results, M1A appears clearly superior to M1 yielding a more stable measure of velocity (Mascaro (1987)).

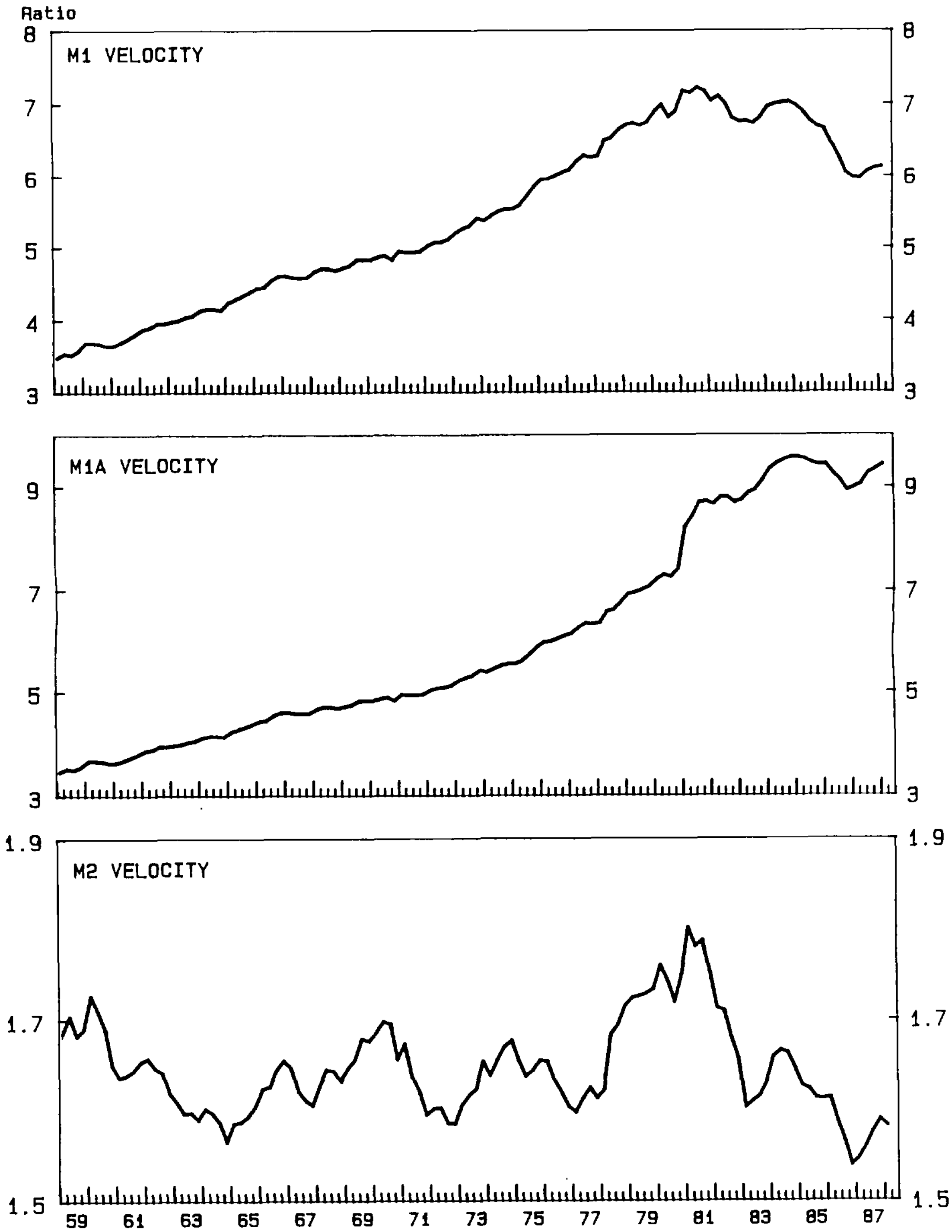
Mascaro's strong support of the M1A approach is based in part on results reported in earlier research work. In particular, Darby, Mascaro, and Marlow (1987) find that M1A has been superior to M1 and M2 as an indicator of the prospective pattern of real growth since 1982.

1/ See the Federal Reserve's February 1988 Monetary Policy Report to Congress.
2/ Stone and Thornton (1987). On this subject, also see Higgins and Faust (1983) and Roth (1984).
3/ M1A consists of currency and noninterest bearing checkable deposits.

CHART 1

UNITED STATES

MONEY VELOCITY



Further, in their analysis of the behavior of quarterly inflation, they argue that M1A remains a superior indicator while M1 is no longer useful. Finally, contrary to Rasche, they conclude that the changed behavior of M1 velocity is traceable to the other checkable deposit (OCD) component of M1 demand.

Given the attention it has received, a few brief observations on some aspects of their work are in order. First, in their analysis of the indicator properties of the various monetary aggregates, it is not entirely clear why any monetary aggregate in and of itself would be a particularly good indicator of the course of real GNP. It is more conventional to find monetary aggregates being targeted on nominal GNP. As noted above, the importance of the velocity equation 1/ derives from the theoretical observation that a monetary aggregate would track nominal GNP if its velocity is stable over time. Second, when looking at their regression equations "explaining" real GNP growth, it is noteworthy that, with few exceptions, the coefficients of the monetary aggregates tend to be insignificant at the 5 percent level. In particular, the coefficients on M1A are insignificant. It would be interesting if the out-of-sample forecasts had included results based on an equation estimated without any monetary regressor.

Third, the fact that the M1 equations in both inflation and real growth exhibit evidence of structural shifts does not necessarily invalidate the use of M1 as an intermediate target variable. In fact Rasche argues that it is still possible to find a parsimonious parameterization of the change in money demand which produces a function that is stable in all other respects and which validates velocity and aggregate money demand functions as useful macroeconomic concepts. 2/

Fourth, the supposed superior performance of M1A over such a short period as the 1980s could be amenable to alternative explanations. 3/ For example, it might be due to two counteracting effects. 4/ At any rate, the shifts in velocity, while they can be parameterized by the judicious use of dummy variables, may still be fundamentally unexplained. Therefore, one cannot rule out the possibility that the superior performance of M1A is statistically spurious. In this connection, it is worth noting that many of the noninterest bearing deposits in M1A are held by businesses under compensating balance arrangements.

1/ Equation (2) above.

2/ Rasche (1987), op. cit. Also, see Rasche (1988).

3/ In this context, it is worth noting that Darby et al (1987) recognize that their equations are reduced form rather than structural and could therefore be consistent with a range of underlying models.

4/ Rasche (1987).

It is not clear that this important component of M1A can be rationalized in terms of a transactions demand motive. 1/

Fifth, and of relevance for the empirical work later, the regressions in the Darby et al. paper were run in levels rather and first differences. 2/

Trends in the velocity of M1A and M2, respectively, are presented in Chart 1. The chart reinforces some of the observations that have already been made concerning alternative velocity measures. While it exhibits no obvious trend, M2 velocity is clearly volatile--though this volatility could be greatly reduced in a fully articulated demand for money equation. Concerning M1A velocity, as argued by Darby et al., unlike M1 velocity, it did not shift in the early 1980s. However, when one considers its most recent behavior, it seems to be exhibiting a pattern not unlike that of M1 velocity. Further, its most recent trend is not unlike the pre-1980 trend in M1 velocity. This possibility was foreseen by Darby et al 3/ and is consistent with their view that M1A has inherited the transactions demand role that M1 had prior to the 1980s. 4/

Granger-Causality tests provide some further information on the potential targeting properties of the alternative monetary aggregates within the context of simple velocity models. 5/ The results for whether any monetary aggregate Granger-causes nominal GNP or inflation

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1/ In addition, the Federal Reserve indicates that the shift toward the substitution of explicit fees for compensating balances may have begun to accelerate in late 1987 (i.e., in a period more recent than that included in the Darby et al. paper). See Board of Governors of the Federal Reserve System, Monetary Policy Report to Congress Pursuant to the Full Employment and Balanced Growth Act of 1978, February 23, 1988.

2/ First differencing transforms series characterized by random walks into a stationary series, i.e., into a series whose stochastic properties are invariant to time. While time series of the levels of monetary aggregates and other macroeconomic variables are unlikely to follow random walks, first differences of those series will tend to reduce the influence of the time trend which is common to all such variables. For further discussion of these points see Johnston (1984).

3/ Op. cit. p. 21.

4/ Note that the 1987 uptick in M1A velocity is also consistent with the Federal Reserve's concern that the decline in the use of compensating balances has accelerated.

5/ Granger "causality" does not mean causality in the usual sense of the term. A variable x is said to Granger-cause y if prediction of the current value of y is enhanced by using past and current values of x. The use of these tests here should be viewed as supplementary rather than definitive. Criticisms of the technique include the possibility that expected future values of x affect the current value of y. For further information see Bishop (1979).

(measured by the GNP deflator) are presented in Tables 1 and 2, respectively. The results are based on quarterly data and are presented for two periods, specifically 1960 to 1980 and 1960 to 1987, so as to help evaluate the impact of the 1980s on the underlying relations. 1/ Finally, the tests are conducted in both level and first difference terms. The latter tests are most likely of greater relevance, because, for the reported F-tests to be meaningful, it is necessary that autocorrelation be eliminated from the regressions. 2/

A number of tentative conclusions emerge. First, confirming the occurrence of a shift in velocity in the early 1980s, money is more likely to Granger-cause nominal GNP in the sample period 1960 to 1980 than in the sample period 1960 to 1987, irrespective of the monetary aggregate under consideration. In particular, Granger-causality breaks down in the case of M1 in the full sample period.

Second, concentrating on the first-difference results for nominal GNP for the full sample period, both M2 and M3 Granger-cause nominal GNP, with the significance levels being somewhat higher in the case of M2. M1A does not Granger-cause nominal GNP at the chosen significance levels.

Third, concerning inflation, the results in Table 2, when compared with those in Table 1, suggest that monetary aggregates are less likely to Granger-cause inflation than nominal GNP. However, although it does not Granger-cause inflation in the subperiod 1960 to 1980, M1A does Granger-cause inflation when the full sample period is under consideration. This is somewhat puzzling suggesting that some factor unique to the early 1980s may be generating the result. 3/

1/ In all cases, the autoregressions for both nominal GNP and inflation extend over four lags (one year). The distributed lag component, however, allows for the impact of whichever monetary aggregate is under consideration to take place over the alternatives of four and eight quarters.

2/ Experience suggests that the regressions run in terms of the levels are likely to be autocorrelated. While there is considerable disagreement over precisely which filter to use to remove the autocorrelation, it seems likely that a first-difference filter at least reduces the problem.

3/ Though not presented here, for completeness tests were also conducted to see whether nominal GNP or inflation Granger-cause the monetary aggregates. The results indicate that, when considering first difference regressions, and testing for significance at the 5 percent level, none of the monetary aggregates is Granger-caused by either nominal GNP or inflation.

Table 1. Nominal GNP and Money. Granger-Causality Tests.

	Number of Lags in Distributed Lag Part	1960-1980	1960-1987
M1A			
Levels	4	F(4,75) = 3.52	F(4,103) = 4.88
	8	F(8,67) = 4.51**	F(8,95) = 2.93
First differences	4	F(4,74) = 5.00	F(4,102) = 4.66
	8	F(8.66) = 4.46**	F(8,94) = 2.78
M1			
Levels	4	F(4,75) = 5.17	F(4,103) = 1.92
	8	F(8,67) = 4.13**	F(8,95) = 1.37
First differences	4	F(4,74) = 5.92**	F(4,102) = 4.62
	8	F(8,66) = 4.26**	F(8,94) = 2.67
M2			
Levels	4	F(4,75) = 7.62**	F(4,103) = 2.89
	8	F(8,67) = 5.88**	F(8,95) = 2.19
First differences	4	F(4,74) = 7.67**	F(4,102) = 7.23**
	8	F(8,66) = 8.89**	F(8,94) = 3.97**
M3			
Levels	4	F(4,75) = 7.83**	F(4,103) = 0.96
	8	F(8,67) = 6.20*	F(8,95) = 1.29
First differences	4	F(4,74) = 9.53**	F(4,102) = 5.80**
	8	F(8,66) = 8.06*	F(8,94) = 3.10**

Notes: * designates significance at the 1 percent level.
** designates significance at the 5 percent level.

Table 2. Inflation and Money. Granger-Causality Tests.

	Number of Lags in Distributed Lag Part	1960-1980	1960-1987
M1A			
Levels	4	F(4,75) = 1.45	F(4,103) = 6.47**
	8	F(8,67) = 1.15	F(8,95) = 3.77**
First differences	4	F(4,74) = 1.81	F(4,102) = 4.22
	8	F(8,66) = 1.57	(F(8.94) = 3.03**
M1			
Levels	4	F(4,75) = 2.76	F(4,103) = 1.31
	8	F(8,67) = 1.93	F(8,95) = 1.30
First differences	4	F(4,74) = 3.03	F(4,102) = 1.33
	8	F(8,66) = 2.78	F(8,94) = 1.60
M2			
Levels	4	F(4,75) = 3.62	F(4,103) = 1.06
	8	F(8,67) = 2.37	F(8,95) = 1.29
First differences	4	F(4,74) = 0.99	F(4,102) = 0.16
	8	F(8,66) = 2.44	F(8,94) = 1.73
M3			
Levels	4	F(4,75) = 3.50	F(4,103) = 0.63
	8	F(8,67) = 2.45	F(8,95) = 1.72
First differences	4	F(4,74) = 2.70	F(4,102) = 0.04
	8	F(8,66) = 3.49**	F(8,94) = 2.96

Notes: Inflation is measured by changes in the GNP deflator.
** designates significance at the 5 percent level.

A final comment on the choice of an appropriate monetary aggregate--there is an alternative approach which relies on aggregation and index number theory to construct monetary aggregates. In this connection, much attention has focused on the Divisia approach which relies on the user costs of basic monetary assets to calculate the contributions of those basic assets to a constructed consistent monetary aggregate. The user costs are proportional to the difference between the yield on a "benchmark" asset, such as human capital, and the relevant component's own yield. 1/ On balance, this approach appears to make more of a difference the broader the monetary aggregate under consideration. A potential problem arises, however, when one considers how such a variable would be controlled by the Federal Reserve. The value of the Divisia approach may, therefore, lie more in indicating that an important source of instability in velocity equations derives from portfolio shifts within the monetary aggregates precipitated by shifts in relative rates of return than in providing an alternative intermediate-variable target.

In the remainder of this section, some alternative explanations of the velocity shift are considered. Still under the heading of model misspecification is an important issue already alluded to, namely, that of the appropriate choice of a scale variable. The common use of nominal GNP as the variable of choice has been rationalized in terms of its being a useful proxy variable for the level of all transactions. With large inventory changes and with the growth in U.S. current account deficits, some have suggested using final sales to domestic purchasers instead. Alternatively, personal income might be preferable. Rasche (1987) rejected these solutions on the grounds that the shift in M1 velocity occurs irrespective of the scale variable selected. Likewise, Rasche finds that substituting wealth or net worth for GNP does not remove the break in the velocity trend.

A potential structural explanation of the shift in M1 velocity concerns the 1979 changes in the Federal Reserve's operating procedures. Although money-stock targeting had been the strategic focus of monetary policy since 1975, the tactics or operating procedures whereby that policy was effected were changed in 1979 from a federal-funds-rate operating strategy to a reserves-oriented strategy. As Rasche points out, the difficulty with using this procedural shift to explain the velocity breakdown lies in the fact that, after accounting for the

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1/ See, for example, Barnett (1980), and Barnett, Offenbacher and Spindt (1981). See also Spindt (1985) for an elaboration of his stock measure.

nationwide introduction of NOW accounts in January 1981, the shift in M1 velocity takes place in late 1981, later than the change in operating procedures.

Another structural explanation could be that an increase in interest rate volatility might have precipitated the shift in velocity. Again, Rasche argues out that the observed increase in interest rate velocity, since it occurred in late 1979 and early 1980, antedates the velocity shift. 1/

As far as cyclical explanations are concerned, Stone and Thornton (1987) identify the possibility that exogenous changes in the supply of M1 could through lags induce cyclical swings in measured velocity. 2/ However, as they themselves point out, such an explanation is unlikely to explain a sustained shift in velocity. At a more general level, however, this point is important since it cautions against automatically assuming that a demand rather than a supply function underlies the velocity relationship.

As an alternative cyclical explanation, Stone and Thornton discuss the role of changes in anticipated inflation in explaining shifts in velocity. By this view, inflation is a proxy for the opportunity cost of holding money. When inflation and presumably inflationary expectations are declining, the demand for money should rise with a concomitant decline being observed in velocity. Stone and Thornton are not persuaded that this variable has a significant role to play in explaining the shift in velocity. 3/ However, others, notably Judd (1983) and Baba, Hendry, and Starr (1987) assign inflation an important role.

A range of explanations have, therefore, been advanced to explain the velocity shift of the early 1980s. While there is a continuing debate on precisely how to resolve the velocity puzzle, it is clear that velocity equations such as equation (2) are overly simplistic. It is therefore important to consider the underlying money demand function in which the velocity models are implicitly embedded.

III. Money Demand Equations

Historically, estimated M1 demand functions for the United States have tended to encounter episodes in which the functions exhibited instability. For example, in 1974 forecasts from the standard M1 equation began seriously to overpredict real money balances--the so-

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1/ Some of the increase in interest velocity could be related to the change in Federal Reserve operating procedures. On this, see Spindt and Tarhan (1987).

2/ Stone and Thornton, op. cit., p. 17.

3/ Stone and Thornton, op. cit., pp. 18-19.

called "missing money" episode. 1/ The recent "great velocity decline" is from this perspective just another episode. The purpose of this section is to present some illustrative regression results so as to evaluate the severity of the problem. While the focus will be on M1demand estimation, where appropriate, results for the demand for other aggregates will also be reported. 2/

A number of steps are involved in moving from a general representation of money demand such as that expressed by equation (1) to an equation which can be empirically estimated. To begin with, all the variables (other than the scale variable) which can affect money demand must be specified. Here, those variables will be assumed to include the price level, P, interest rate variables gauging both the own return on money and the return on competing assets, r_i, the expected rate of inflation (i.e., a rate of return/opportunity cost variable), $\dot{P}^e$, a variable gauging the variability of financial returns, VAR, and dummy variables to accommodate monetary supply shocks (specifically in the form of credit controls), D_i. This selection of variables is suggested by the literature discussed earlier.

It is assumed that nominal money demand is homogeneous degree one in prices--that is, if the price level doubles, so does nominal money demand. This permits a re-expression of the money demand equations in terms of real money demand as follows:

$$\frac{M}{P} = f(\frac{Y}{P}, r_i, \dot{P}^e, \text{VAR}, D_i) \qquad (3)$$

A conventional way of estimating this equation would be to run a regression in the logarithms of these variables, including a lagged value of the dependent variable. This type of formulation--commonly referred to as the Goldfeld specification--has been favored since it can be motivated by an appeal to portfolio adjustment costs (Goldfeld (1973)). Equation (3) may then be viewed as characterizing the level of real money balances that will be attained in the long run. In the shorter run, however, equilibrium is assumed not to be reached instantaneously, with real money balances adjusting to the gap between the desired or "long-run" demand and the previous period's actual holdings. Incorporating this partial adjustment effect leads to the inclusion of lagged values of the dependent variable in the regression.

The question is, why would adjustment be other than instantaneous? Goldfeld (1973) appeals to the existence of portfolio adjustment costs. Others argue that money balances serve as a shock absorber or buffer

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1/ See Judd and Scadding (1982), Goldfeld (1973, 1986).

2/ Since the exercise in this section is illustrative, it fails to do justice to the broad range of theoretical and econometric issues which any comprehensive attempt to estimate U.S. money demand would have to address. For a review of these issues, the reader is referred to Cuthbertson (1985).

stock which temporarily absorbs unexpected income variations until other portfolio components can be adjusted. 1/ However, as pointed out by Goodfriend, 2/ it is difficult to place these types of rationalization on a firm theoretical foundation, particularly given the availability of relatively close substitutes to money where these substitutes are notable for the ease with which transactions can be made in them. It should be noted in this connection that empirically the estimated coefficient on the lagged value of real money balances implies an extremely long adjustment period.

Goodfriend demonstrates that the Goldfeld specification can be retained if it is interpreted as being derived from a model where true money demand adjusts completely within a period but where the regressors are measured with error. More generally, though, there is no need artificially to restrict oneself to the simplistic lag structure implied by the partial adjustment framework. It would seem preferable to start from a more general class of autoregressive distributed-lag equations, in principle allowing for multiple lagged values of both the dependent and independent variables. 3/

That is the approach adopted in this paper. A general autoregressive distributed lag model (ADL) is used that yields a static long-run equilibrium solution consistent with the economic theory delineated above. The resultant equation is sequentially simplified (i.e., "tested down") by dropping insignificant high-order lags. In this manner, it

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1/ For example, Darby (1972), Carr and Darby (1981) and Darby, Mascaro, and Marlow (1987).

2/ See Goodfriend (1985). Note that this issue is not independent of the frequency of the data under consideration. Partial adjustment would hardly be justifiable if annual data are used. On this point, Rasche (1987 p. 23) notes that research based on the monthly level of disaggregation is associated with the Federal Reserve System while the academic literature has focused on quarterly data. This paper will use quarterly data.

3/ This part of the discussion owes much to the work of Hendry (see, for example, Hendry, Pagan, and Sargan (1982), Hendry and Richard (1982), Baba, Hendry, and Starr (1987)). As an example, consider a first order version of an autoregressive distributed lag equation.

$$Y_t = \beta_0 + \beta_1 X_t + \beta_2 X_{t-1} + \beta_3 Y_{t-1} + \varepsilon_t$$

The partial adjustment approach is tantamount to setting $\beta_2 = 0$; this may be an unwarranted *a priori* restriction. For further elaboration, see Gordon (1984).

emerges that an "error-correction" model may be a useful representation for M1 in the United States. 1/

On more specific matters, the regressions are run in the logarithms of real money balances and the scale variable. This is tantamount to imposing the restriction that the elasticity of real money demand to changes in the scale variable be constant, a restriction that is common to much of the literature. However, such a restriction may well be arbitrary in the case of the other variables. In particular, given the possibility that the interest-elasticity of money demand may have increased in the 1980s and given the advent of high short-term nominal rates, a semi-log specification is assumed for the rate of return variables. 2/

The dependent variable, designated as (M1/P), is seasonally adjusted M1 deflated by the implicit GNP deflator. 3/ The independent variables selected are the following:

a. Scale variable

While many variables have been used in the role of a scale variable, for the purposes of this paper the choice can be reduced to deciding between a wealth variable and an income variable and, among

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1/ The error-correction model assumes the existence of a long-run stable demand function for real money balances, deviations from which encourage adjustments to re-establish equilibrium. Referring to the first-order (ADL) example of the previous footnote, the error correction model takes the original equation and imposing for example the restriction

$\beta_1 + \beta_2 + \beta_3 = 1$ derives the following:

$$\Delta Y_t = \beta_0 + \beta_1 \Delta X_t + (1 - \beta_3)(X - Y)_{t-1} + \varepsilon_t$$

where Δ indicates that the relevant variable has been first differenced. The term in $(X-Y)_{t-1}$ is the error-correction term--it measures the "error" in the previous period and agents "correct" their decision about Y_t in light of this disequilibrium. This equation form, which is not imposed at the outset, offers two advantages. By first-differencing, the possibility of running a spurious regression is reduced. Second, since it is not a pure first-difference equation ($\beta_3 \neq 1$), there is a determinate long-run equilibrium solution.

2/ See Rasche (1987).

3/ The GNP deflator was selected so as to be consistent with equation (3). As is pointed out in the next section, real GNP is the scale variable of choice in the real M1 demand equations. For a paper which also considers the demand for alternative measures of "transactions money" such as the Divisia measure mentioned above, see Rasche (1988).

income variables, between using real GNP or some other variable such as real consumption. 1/

On the matter of wealth versus income, the issue is whether the motivation for including the scale variable is based on the inventory-theoretic transactions demand approach to money demand, or on a Tobinesque portfolio balance approach. In this paper it is presumed that M1 remains sufficiently narrow to warrant the use of an income variable. 2/ As for the choice of real GNP as opposed to real consumption, the real GNP variable performed significantly better in the regression equations for M1. The variable is designated as Y.

b. Opportunity cost variables

The choice of appropriate opportunity cost variables raises a number of distinct issues. First, there is the question of whether a short-term or a long-term interest rate should be included as a measure of the opportunity cost of holding money in terms of other financial assets. However, this choice appears not to be crucial to the empirical results, undoubtedly because of the tendency for interest rates on a wide variety of assets to move together. 3/ In this paper, the three-month Treasury bill rate, designated as r, is included as the opportunity cost variable.

Hamberger (1966) included the dividend-price ratio as a proxy variable for the rate of return on equities and thus on physical capital. While the reliability of his empirical results has subsequently been questioned, nonetheless, his approach raises the possibility that the range of assets competing with M1 could be quite broad. 4/ In this paper, the expected rate of inflation, designated $\dot{P}^e$, is introduced to perform this broader role. After trying various formulations of how this variable might be specified, a simple measure based on the concurrent difference of the logarithms of the index of the quarterly implicit GNP deflator was selected.

With the arrival of NOW and Super NOW accounts, the issue of the own-rate of return on M1 has received more attention. How to calculate this return accurately is, however, problematical, since returns can be paid in forms other than explicit interest rates. One approach has been to assume that the interest rate paid on demand deposits varies with the

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1/ The discussion of the available options cannot be exhaustive. Examples of other measures which have been used as a scale variable include bank debits (See Lieberman (1977)) and the level of bank loans.
2/ For an alternative view, see Laidler (1985), Hamberger (1983) and Hamberger (1986).
3/ Laidler (1985).
4/ See Hafer and Hein (1979).

charges levied on checking accounts. 1/ Another approach takes as its starting point the view that the banking system is competitive and that therefore the yield on noninterest bearing demand deposits will equal the return the bank gets when investing the deposits. 2/ In the context of this paper, an attempt was made to accommodate the own-rate of return by adjusting the Treasury bill interest rate for the NOW account interest rate weighted by the share of NOW accounts in M1. The variable, however, did not perform well. Given the success others have experienced with more sophisticated forms of this variable, this is most likely a reflection of the relatively crude manner in which the variable was calculated. 3/

c. Other variables

Two variables should be mentioned under this heading. First, an attempt is made to accommodate the potential impact the increased interest-rate volatility of the 1980s might have had on money demand. Note that it is difficult to rationalize the inclusion of a volatility variable into a model with complete capital markets--in such a world, investors can always hedge against risk. However, in a world with capital market imperfections, this type of variable may be theoretically justifiable. The expectation is that the coefficient on this variable would be positive--an increase in volatility would entice agents to remain more liquid than they would otherwise be. The actual variable has been constructed by taking the standard deviation of the two-period moving average of the ten-year government bond rate. 4/ The variable is designated as VAR.

Finally, following Gordon (1984), whose work supports the conjecture that the credit controls sharply reduced the money supply in 1980:Q2 and contributed to a roughly equivalent rebound in money supply in 1980:Q3, a dummy variable, D, is included with the values -1, 1, in those two quarters, respectively, and zero elsewhere.

The following baseline "error-correction" model for M1 demand using quarterly data (1960:2 to 1988:1) was developed.

1/ See Lee (1967).
2/ For example, Klein (1974).
3/ See, for example, Baba, Hendry, and Starr (1987).
4/ The lengths are arbitrary. However, it should be noted that if the moving average were extended over many periods, the variable would be smooth, defeating the purpose.

$$\Delta\ln(M1/P) = \underset{(5.096)}{0.059} + \underset{(6.002)}{0.426}\Delta\ln(M1/P)_{-1} - \underset{(-4.694)}{0.039}(\ln(M1/P) - 0.65\ln(Y/P))_{-2}$$

$$- \underset{(-1.145)}{0.001}\,\Delta r - \underset{(-6.271)}{0.004}\Delta r_{-1} - \underset{(-3.967)}{0.0015}r_{-3} + \underset{(2.131)}{0.005}VAR \qquad (4)$$

$$- \underset{(-6.332)}{0.805}\,\Delta\dot{P}^e - \underset{(-3.309)}{0.500}\Delta\dot{P}^e_{-1} - \underset{(-4.086)}{0.576}\dot{P}^e_{-2} + \underset{(6.292)}{0.029}D$$

$\bar{R}^2 = 0.8028$ $F(10,101) = 41.12$ $\sigma = 0.00540$

LM Test for Autocorrelation 1/

$\eta_1(1,100) = 0.80$ $\eta_2(1,100) = 1.57$ $\eta_3(4,97) = 0.83$

LM Test for Autocorrelated Squared Residuals. 2/

$F(4,96) = 0.34$ $F(4,96)$ Critical Value = 2.47

Tests for Heteroskedasticity. 3/

$F(20,79) = 0.83$ $F(20,79)$ critical value = 1.70

The t-ratios are in parentheses. This equation satisfies a range of diagnostic tests. Particularly noteworthy is the absence of autocorrelation. To interpret this equation, consider the properties of the equilibrium solution. Setting the terms in differences equal to zero, the derived equilibrium solution is:

$$\ln(M1/P) = 1.1513 + 0.65\ln Y/P - 0.038r + 0.128VAR - 14.769\dot{P}^e \qquad (5)$$

The income elasticity of M1 demand is 0.65. (As can be seen from equation (4), 0.65 is the value on Y/P in the error-correction term.

1/ η_1 (1,T-k-1) denotes a Lagrange multiplier F-test for residual serial autocorrelation of order 1 with k regressors, η_2 is for simple fourth-order autocorrelation, and η_3 is for orders 1 through 4. The test is distributed as χ^2 in large samples under the null hypothesis that there is no autocorrelation. However, for finite samples, the F-test reported here, with its critical value at the 0.5 percent level, is preferable as a diagnostic test (Harvey (1981)). Note that this test is valid for models with lagged dependent variables.

2/ This is Engle's "ARCH" test (Auto Regressive Conditional Heteroskedasticity). Engle (1982).

3/ Due to White (1980).

This value was not imposed but was suggested by the ratio of the estimated coefficients of a prior regression equation in which $\ln(M1/P)_{-2}$ and $\ln(Y/P)_{-2}$ were entered separately.) This is consistent with the view that there should be economies of scale in M1 holdings. The (competing yield) interest elasticity of money is:

$$E_{M1/P,r} = -0.038r$$

where this equals 0.38 at an interest rate of 10 percent per annum. Analogously, the elasticity of real M1 to changes in the expected rate of inflation is 0.37 at an expected annual rate of inflation of 10 percent. 1/ Finally, at its mean value for the 1980s, the elasticity of real M1 to changes in the volatility variable is 0.128.

Given the concern with the capacity of monetary aggregates to track macroeconomic variables, the real issue is whether the equation resolves the instability issues discussed above. In Chart 2, the one-step residuals $(Y_t - X_t' \beta_t = u_t$ where β_t is the estimated β using data up to and including t) are graphed together with their current standard errors ($\pm 2\sigma_t$). This graph, as might be expected, indicates that a period of instability in the real M1 equation occurred in the early 1980s. In other words, the representative regression equation presented here, though performing well by a number of criteria, does not fully "explain" the velocity decline. 2/ (However, when Chart 2 is compared with analogous charts of residual behavior for alternative traditional real M1 demand equations, the evidence suggests that the results presented here represent a significant improvement.)

More interesting is the indication that the regression equation began again to exhibit some signs of instability in more recent years. This impression is confirmed by Chart 3, in which is presented an analysis of one-step ahead forecasts for the period 1986:1 to 1988:1. The bounds around the forecast paths are set for the 5 percent confidence level. In particular, the chart indicates that, in the third quarter of 1987, the equation was overpredicting real M1 demand. Further a χ^2 test comparing within and post-sample residual variances for parameter constancy rejects the hypothesis of parameter constancy at the 5 percent confidence level. This is a further indication that the ongoing process of financial reform and innovation may be continuing to have an unsettling impact on established empirical relationships.

To explore this issue of parameter constancy further, consider the same equation estimated over the truncated period 1960:2 to 1980:3.

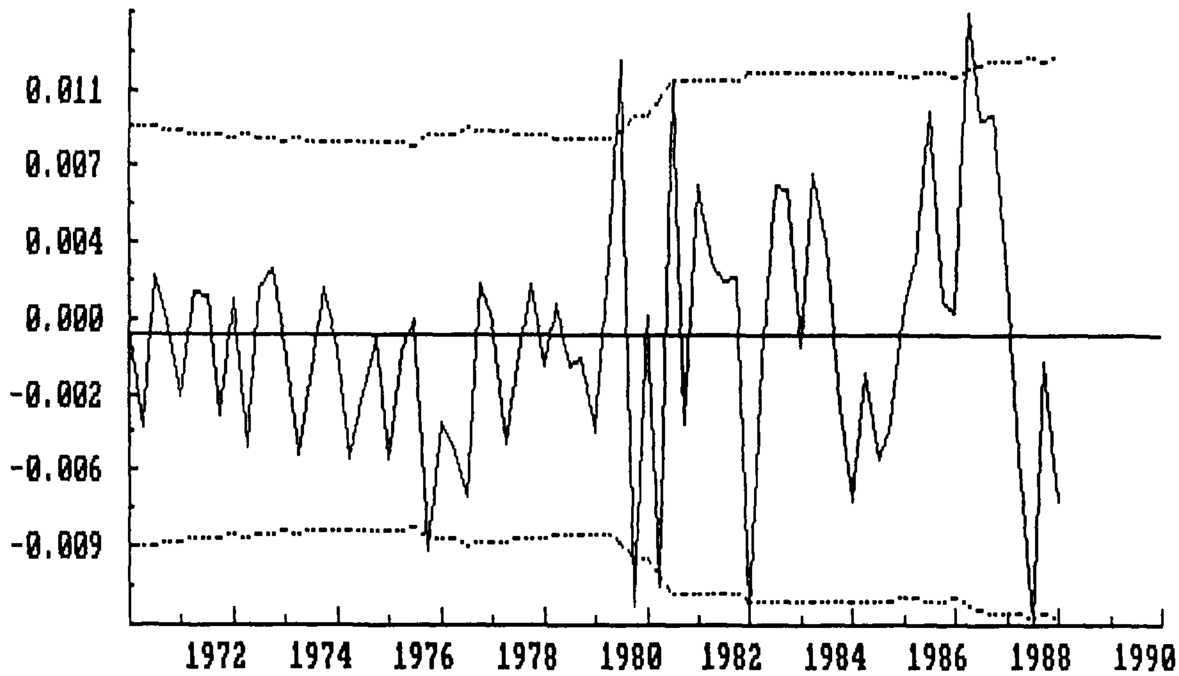
1/ This takes into account the fact that the coefficient value is based on a quarterly rate of inflation.

2/ However, using an equation which deals more comprehensively with the interest-rate volatility issue and which also allows for the impact of taxation, Baba, Hendry, and Starr (1987) op. cit., claim to be able to "explain" this period.

Chart 2

United States

Real M1 Equation: Residuals 1/

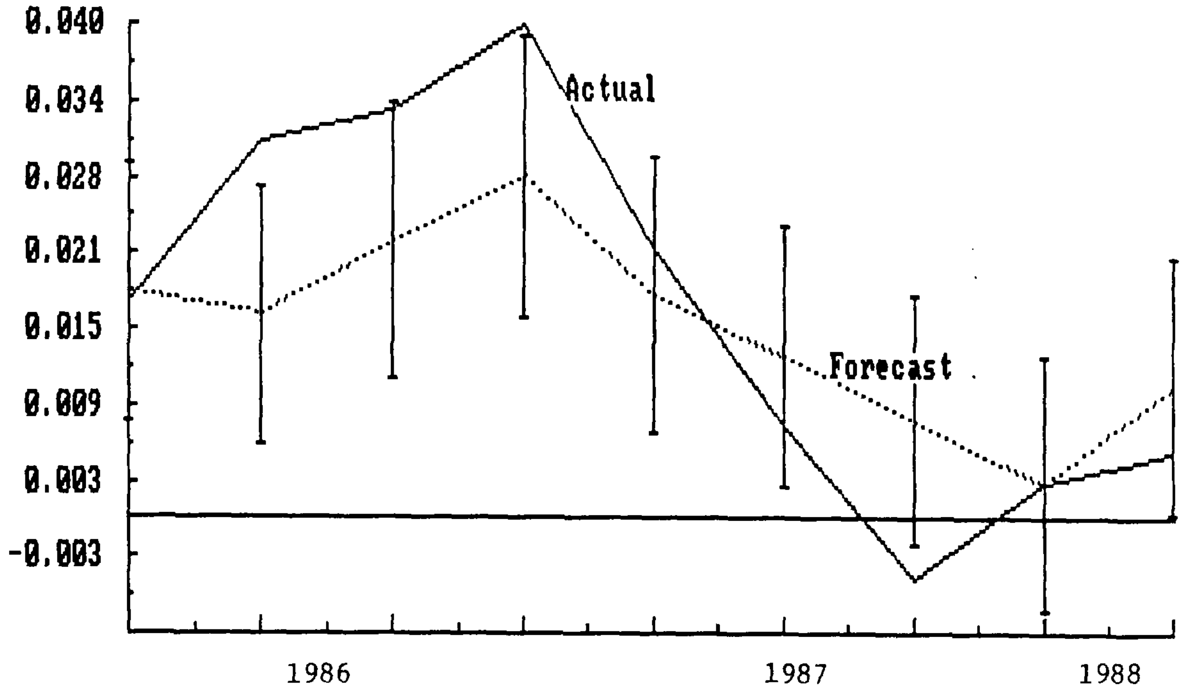


1/ One step residuals ($Y_t - x_t'\hat{\beta}_t = \bar{u}_t$ where $\hat{\beta}_t$ is the estimated $\hat{\beta}$ using data up to and including t) bounded by the current standard errors ($\pm 2\ \hat{\sigma}_t$)

Chart 3

United States

Real M1 Equation: Forecast Performance 1/



1/ The error bars show plus or minus two standard errors of the estimated value for the dependent variable, yielding an approximately 95 percent confidence interval for the one-step forecast.

$$\Delta \ln(M1/P) = \underset{(4.026)}{0.055} + \underset{(3.322)}{0.359}\Delta(\ln M1/P)_{-1} - \underset{(-3.766)}{0.037}(\ln M1/P - 0.65 \ln Y/P)_{-2}$$

$$- \underset{(-0.328)}{0.0003}\Delta r - \underset{(-2.790)}{0.003}\Delta r_{-1} - \underset{(-1.024)}{0.0006}r_{-3} + \underset{(0.017)}{0.00007}VAR \qquad (6)$$

$$- \underset{(-6.182)}{0.870}\Delta\dot{P}^{e} - \underset{(-3.380)}{0.612}\Delta\dot{P}^{e}_{-1} - \underset{(-3.847)}{0.746}\dot{P}^{e}_{-2} + \underset{(5.276)}{0.029}D$$

$\bar{R}^2 = 0.743$ $F(10,71) = 20.50$ $\sigma = 0.005$

$\eta_1(1,70) = 0.02$ $\eta_2(1,70) = 0.15$ $\eta_3(4,68) = 0.49$

ARCH: $F(4,66) = 0.93$ $F(4,67)$ Critical Value = 2.51

Heteroskedasticity: $F(20,50) = 1.32$ $F(20,50)$ Critical Value = 1.78

The obvious differences between this and the previous regression are first that, not surprisingly, the variability variable is less significant and, second, the competing rate of return variable performs poorly.

Some indication of why the competing rate of return variable (r) does not perform so well can be found in Chart 4. This chart presents the recursive least squares coefficient for r_{-3} (intuitively, the chart tracks the estimated coefficient for that variable as more observations are added to the regression) which shows that until the late 1970s, the coefficient was not significantly different from zero, but became significantly negative thereafter. 1/ It is evidence such as this that has led many to conclude that the interest elasticity of demand for real money balances has increased. That result is increasingly being cited as an additional reason for downplaying the potential targetting role of M1. Even if the M1 demand relationship were to be found to be stable, the increased interest elasticity of demand for money may be sufficient to negate the usefulness of M1 as an intermediate target variable. The target band established for M1 would have to be very broad to accommodate the range of shocks that might reasonably be expected to occur. Such a wide bandwould be of little use in the conduct of

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1/ To permit a solution, the dummy variable, D, was dropped from the recursive least squares equation.

monetary policy or in communicating the stance of that policy to the public. 1/

For comparison, equations for real M1A and real M2 were also estimated. Equation (7) presents an illustrative regression equation for M1A, where the modelling strategy pursued was analogous to that underlying equations (5) and (6). The sample period is 1960:3 to 1988:1.

$$\Delta\ln(M1A/P) = \underset{(-3.394)}{-0.292} + \underset{(5.805)}{0.333}\Delta\ln(M1A/P)_{-1} + \underset{(2.536)}{0.026}\ln(M1A/P)_{-2}$$

$$- \underset{(-7.487)}{0.006}\,\Delta r_{-1} - \underset{(-7.199)}{0.990}\dot{P}^e + \underset{(4.131)}{0.019}\ln Y/P_{-2}$$

$$+ \underset{(2.231)}{0.0119}D - \underset{(-2.290)}{0.006}VAR_{-4} \qquad (7)$$

$\bar{R}^2 = 0.728 \qquad F(7,103) = 39.45 \qquad \sigma = 0.007$

$\eta_1(1,102) = 0.29 \qquad \eta_2(1,102) = 0.01 \qquad \eta_3(4,99) = 0.37$

ARCH: $F(4,98) = 0.58$ $\quad F(4,98)$ Critical Value = 2.46

Heteroskedasticity: $F(14,88) = 18.89$ $\quad F(14,88)$ Critical Value = 1.81

A technical point should be noted at the outset. Real consumption (C/P) is the regressor of choice for the scale variable after equations were fitted using both GNP and consumption. This may lend support to the view that M1A is a better gauge of transactions demand than are other monetary aggregates. This point should not be accorded too much weight because the differences between the regressions in the alternative scale variables are not large and because, theoretically, it is difficult to see why demand deposits should be preferred to interest-bearing checking accounts as transactions balances.

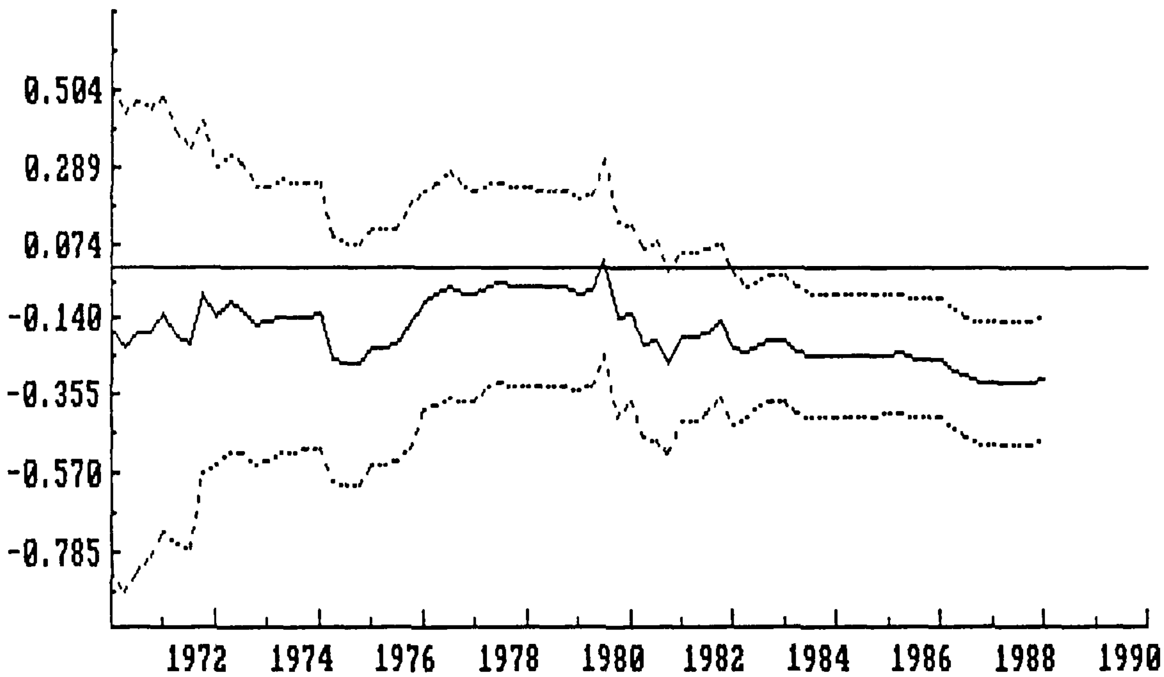
As can be seen by the positive coefficient on real M1A lagged two periods, the equation is inconsistent with an "error-correction"

1/ As an aside, the increased interest sensitivity of money demand may in some degree reflect the switch which occurred in the Federal Reserve's operating procedures at that time. Seen in that light, the low coefficient value for the 1970s may be in part due to the Federal Reserve's policy of targeting interest rates. Of course, to the extent that this explanation is valid, it implies some simultaneity between money and interest rates.

Chart 4

United States

Real M1 Equation: Bounded Recursive Least Squares Coefficient for r_{-3} 1/



1/ The estimated value of the coefficient of the variable calculated by recursive least squares and bounded by plus or minus two standard errors of that estimated value.

model 1/ Instead, the implied relationship is explosive and it is impossible to solve for a long-run solution. Some insight into the source of the problem can be found in Chart 5 in which the recursive least squares coefficient for the lagged value of real M1A is presented. Following a period in which there was a tendency for its value to be negative, the coefficient became significantly positive in the 1980s.

This outcome supports the point made in the context of the Granger-Causality tests--caution should be exercised in interpreting the superior tracking ability of M1A through 1985/86 since that superior performance could be spurious. This point is reinforced by a consideration of the equation's forecasting characteristics which are displayed in Chart 6. In recent quarters, the equation has been showing signs of going off-track. 2/

A representative equation for the demand for real M2 balances is:

$$\begin{aligned}
\Delta \ln(M2/P) = & \underset{(-2.380)}{-0.027} + \underset{(6.693)}{0.494}\, \Delta \ln(M2/P)_{-1} + \underset{(2.688)}{0.173} \Delta \ln Y/P \qquad (8) \\
& + \underset{(2.000)}{0.128} \Delta \ln(Y/P)_{-1} - \underset{(-2.935)}{0.071}\, (\ln M2/P - \ln Y/P)_{-2} \\
& \underset{(-7.616)}{-0.881} \Delta \dot{P}^{e} - \underset{(-2.729)}{0.296} \dot{P}^{e}_{-1} \underset{(-3.62)}{-0.002} \Delta r - \underset{(-5.003)}{.003} \Delta r_{-1} \\
& \underset{(-1.607)}{-0.0004} r_{-2} + \underset{(2.336)}{0.01} D
\end{aligned}$$

$\bar{R}^2 = 0.777$ $\qquad F(10,99) = 34.59$ $\qquad \sigma = 0.0005$ $\qquad$ 1960:4 to 1988:1

$\eta_1(1,98) = 2.06$ $\qquad \eta_2(1,98) = 2.31$ $\qquad \eta_3(4,95) = 2.18$

1/ The regression also significantly exceeds the critical value for heteroskedasticity. However, this may not be crucial since the presence of heteroskedasticity may in effect just mean that the equation is not being efficiently estimated.

2/ It should be noted that, using a different estimating equation, Rasche (1988 op. cit.) had greater success in estimating an M1A equation. However, when considering the forecasting properties of that equation for 1986-87, he found that the standard deviation of the projection residuals was very large relative to the standard error of the sample period residuals. This feature also emerged in his estimated equations for M1 demand.

ARCH: F(4,94) = 0.96 F(4.94) Critical Value = 2.47

Heteroskedasticity: F(20,78) = 0.73 F(20,78) Critical Value = 1.71

A distinguishing feature of this equation is that the error-correction term suggested by the "testing-down" approach implies an income elasticity of unity. This may reflect the broader nature of M2, weakening the link between M2 and an underlying inventory-theoretic transactions based approach to money demand. In many other respects, this equation is similar to the estimated equation for real M1 demand. In fact, by the criterion of its forecasting ability, this equation outperforms the preceding equations. In particular, Chart 7 shows that the forecasts track actual developments closely through 1986:1 to 1988:1. Further, the equation satisfies tests for parameter constancy over that period. 1/

However, these results do not necessarily mean that M2 should or could replace M1 as an intermediate-variable target. M2 is a relatively broad aggregate and, as has already been argued, this raises questions concerning the Federal Reserve's ability satisfactorily to control its path. 2/ Further, as with other monetary aggregates, the continuing process of deregulation is altering the nature of M2 over time. For example, in 1980 the deposit rates on most instruments were regulated whereas this is no longer the case. 3/

IV. Concluding Observations

The intent of this paper has been to assess the performance of velocity and money demand models in the United States. The paper began by considering velocity models. It was argued that these models have broken down in the 1980s primarily because of changes in the behavior of variables other than the scale variable. It would be beyond the scope of this paper to assign "blame" for the collapse in the predictive abil-

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1/ The Chow test for parameter constancy has an F value of F(9,90) = 0.64 where the critical value is F(9,90) = 1.99.

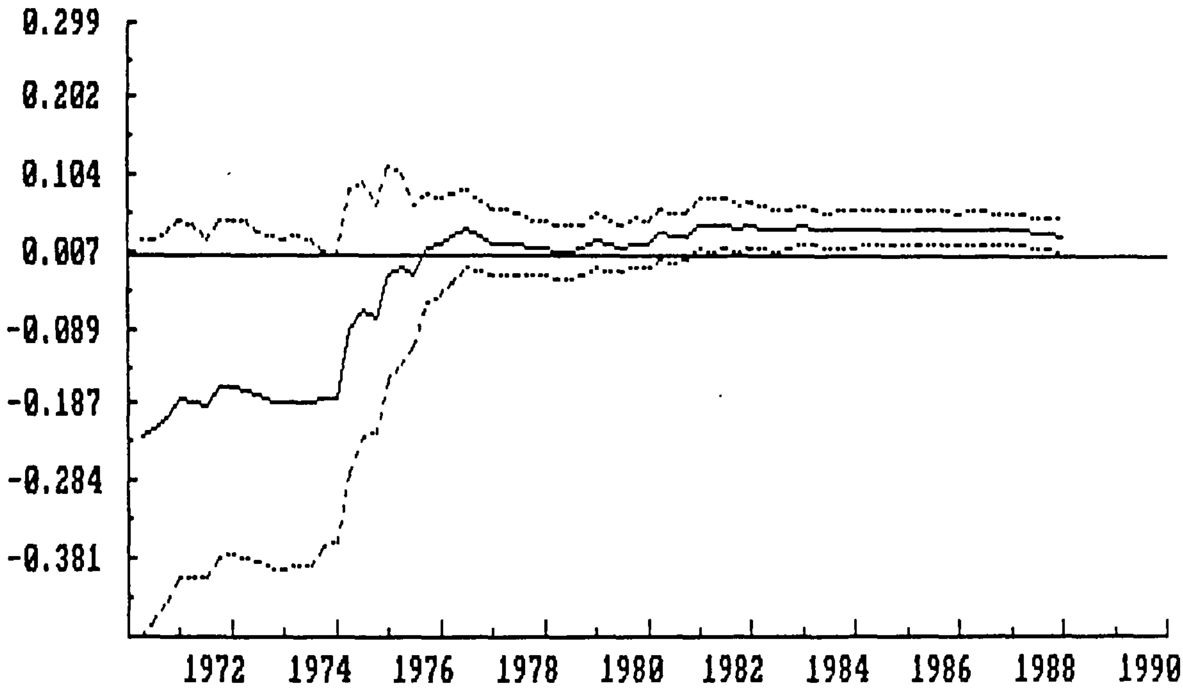
2/ Darby et al (1987) also uncover circumstances where M2 performs well but are concerned that the savings-based motivation for holding some components of M2 could detract from its role as an intermediate target variable.

3/ This has led Motley to argue for the specification of a new monetary aggregate based on distinguishing between those deposits that have a specified term to maturity and those that have no fixed term and that hence, for all practical purposes, are withdrawable on demand. An aggregate of the latter type of deposits, it is argued, would recreate an aggregate gauging nonsavings, transaction demand for money. See Motley (1988).

Chart 5

United States

Bounded Recursive Least Squares Coefficient for $Ln(M1A/P)_{-2}$ 1/

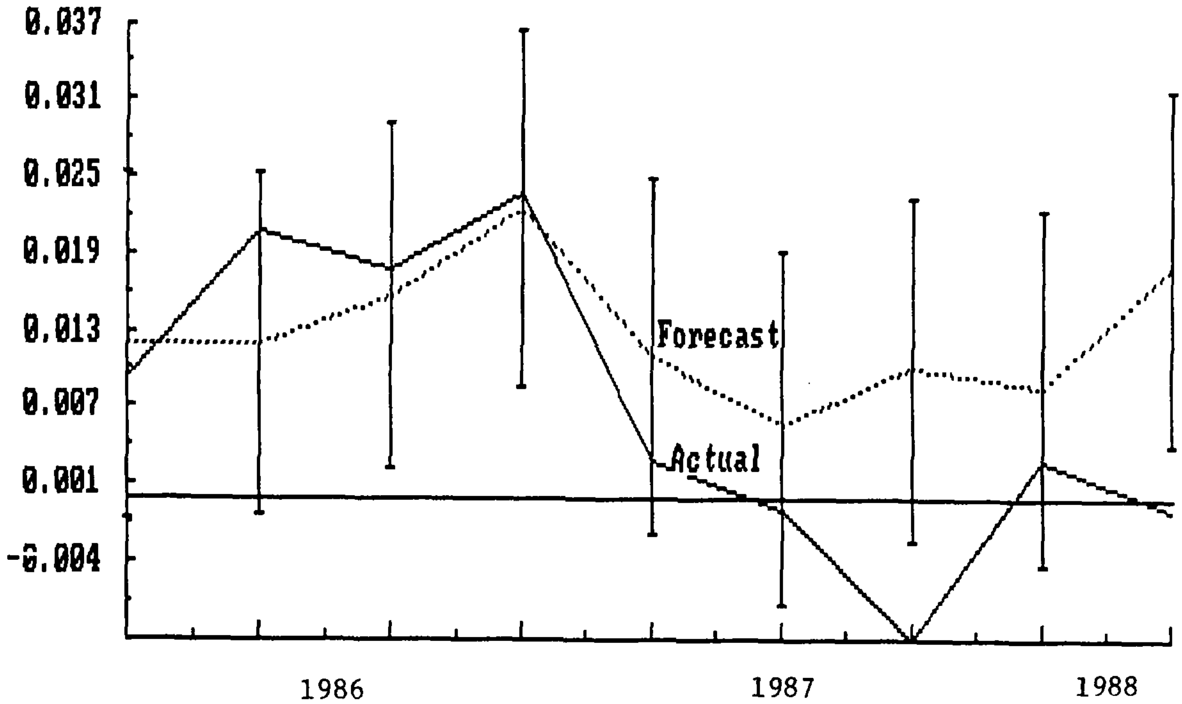


1/ The estimated value of the coefficient of the variable calculated by recursive least squares and bounded by plus or minus two standard errors of that estimated value.

Chart 6

United States

Real M1A Equation: Forecast Performance 1/

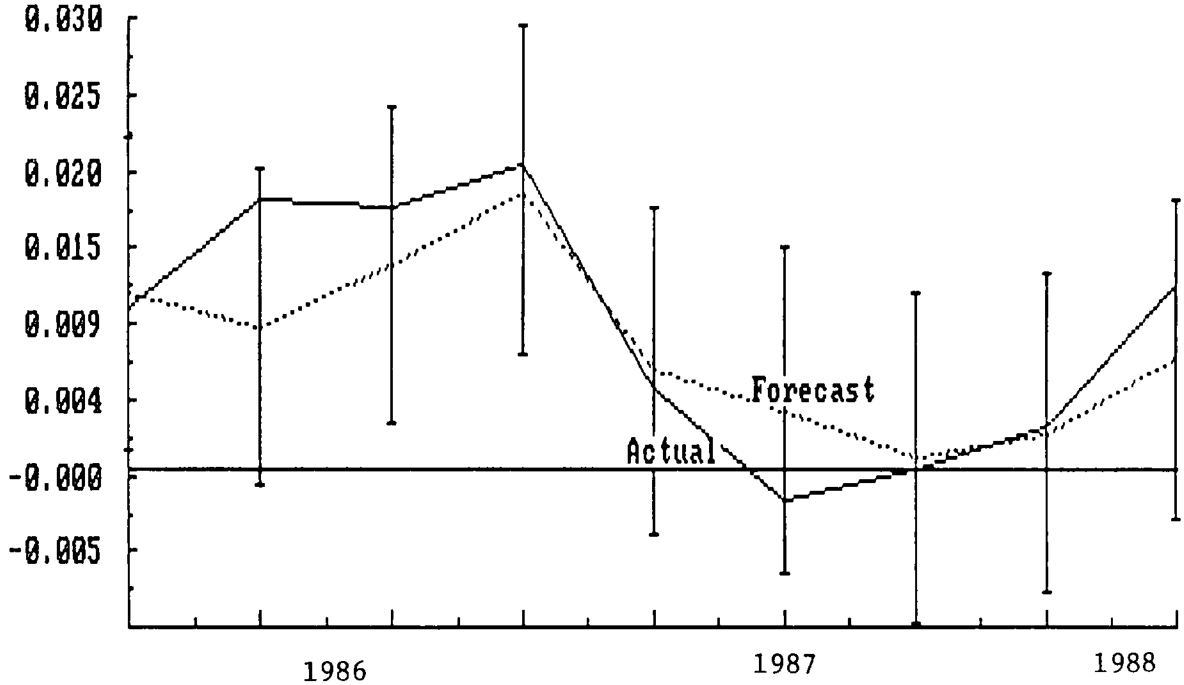


1/ The error bars show plus or minus two standard errors of the estimated value for the dependent variable, yielding an approximately 95 percent confidence interval for the one-step forecast.

Chart 7

United States

Real M2 Equation: Forecast Performance 1/



1/ The error bars show plus or minus two standard errors of the estimated value for the dependent variable, yielding an approximately 95 percent confidence interval for the one-step forecast.

ity of these models to a particular set of variables. However, it does appear that the heightened pace of regulatory reform in financial markets has had a major role to play. Further, the recent erratic behavior of velocity models extends to monetary aggregates other than M1.

Given the problems with velocity models, the paper also presented regression results of more fully articulated money-demand functions. A generalized autoregressive distributed lag approach was used, the merits of which include the fact that such an approach avoids the arbitrary lag structure and autocorrelation correction techniques of more traditional functional specifications of money-demand. The regressions work quite well and, in particular, they suggest that financial deregulation has had an impact on the demand for various monetary aggregates. Specifically, the results indicate that it is difficult to predict the demand for M1 and M1A. 1/ On face value, the equation for M2 is better behaved.

Finally, this paper tends to confirm that the interest elasticity of demand for real M1 balances has increased in recent years. This increase complicates the use of monetary aggregates--such as M1--as intermediate target variables.

1/ This observation should be qualified in light of the fact that the equations of Baba, Hendry, and Starr (1987 op. cit.), for example, track real M1 demand through 1985 more accurately than the equations presented here. It is therefore conceivable that a more comprehensive regression equation could "explain" the deterioration in the forecasting ability of the equations presented here.

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